Control of Visual Quality Consistency
Application to Ham Slices

Results obtained at Alpha MOS Laboratory (Toulouse, France).

Application Note

ANI 01

Objective

In the retail environment, the appearance of a product is often the main quality indicator available to consumers and determines their decision to purchase or not. This is especially true of refrigerated products such as packed ham slices, for which the visual aspect is closely related with the product freshness and quality.

This study proposes to analyze different batches and recipes of pork ham slices with an Electronic Eye. The objectives are to check the batch to batch consistency (color and shape) and to detect the visual differences between various recipes.

IRIS Electronic Eye

IRIS analyzer achieves a detailed visual assessment of both color and shape parameters of the overall products or selected portions of these products.

Camera imaging

- 16 million colors imaging
- Integrated zoom
- Automated monitoring by software

Light cabin

- Reproducible lighting conditions, D65 compliant, 6700°K color temperature
- Top and bottom lighting (backlighting to avoid shadow effects)
- Large measurement surface (420 x 560mm)

E-Eye Alphasoft software

- Data acquisition
- Automated color calibration
- Data processing (color and shape analysis)
- Multivariate Statistics (Principal Components Analysis, Statistical Quality Control, etc)

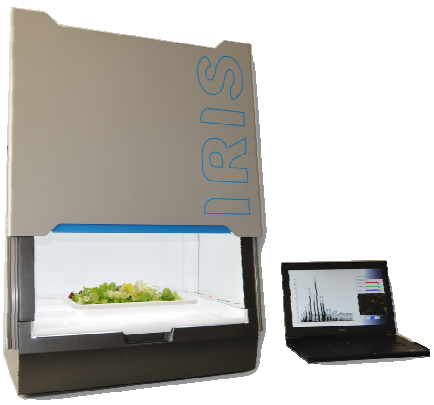
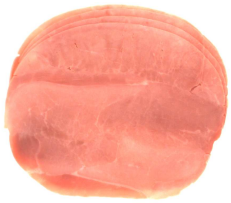


Figure 1: IRIS Electronic Eye

Samples & Analytical Method

The set of twelve samples consists of four different batches of three types of rindless pork ham slices: current recipe (CR1 to CR4), new recipe (NR1 to NR4) and reduced salt recipe (RS1 to RS4).

For each sample, 2 pictures were taken:



Within the package after opening the protecting film (from above), for color analysis

Upper slice, isolated (out of the package), for shape analysis

The ham slices were analysed on a transparent tray within the light cabin of IRIS electronic eye.

For the analysis of the visual parameters, a thresholding of the pictures was achieved so as to cut out the background (fig. 2).

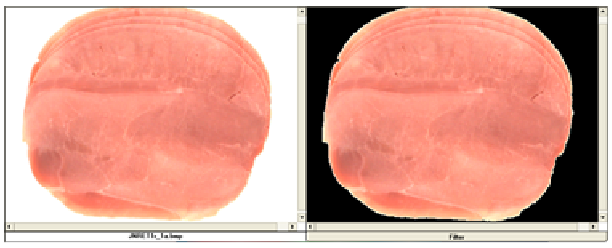


Figure 2: Removal of the pictures background by applying a thresholding

Color Analysis

With IRIS electronic eye, it is possible to analyze colors on the whole surface of ham slices, in one acquisition.

The picture of ham slices can be processed as a color spectrum (fig.3). This bar graph represents the proportion of each color (percentage) in the picture, within a fixed scale of 4096 colors.

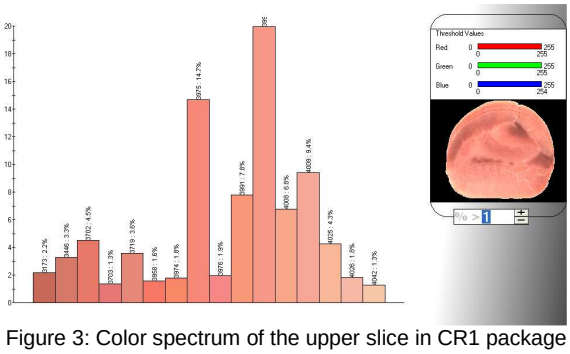


Figure 3: Color spectrum of the upper slice in CR1 package

To rapidly compare the global color profile of all samples, the color spectrum data are processed by Principal Components Analysis (fig. 4).

The three recipes show significant color differences even if the current and the new recipes are closer one to another whereas the reduced salt recipe is farther.

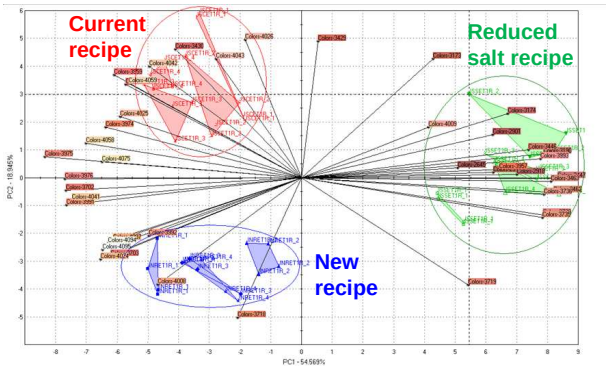


Figure 4: Principal Components Analysis of upper slices of all ham packages based on color parameters

Principal Components Analysis (fig. 5 to 7) was also applied to each recipe of ham separately, to evaluate the batch to batch consistency based on color parameters.

Within the current recipe type (fig.5), the batches have a homogeneous color profile.

For the new recipe (fig.6), batches are significantly different based on the hour of production.

A similar distinction can be observed for the reduced salt recipe (fig.7), for which the first package (RS1) is quite different from the three others and was produced at a different time compared with other batches.

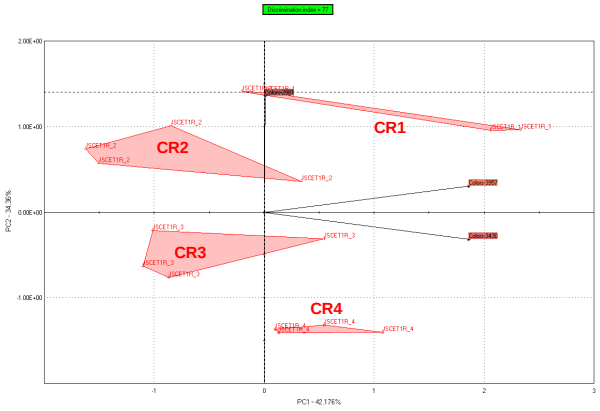


Figure 5: Principal Components Analysis of upper slices of all current recipe packages

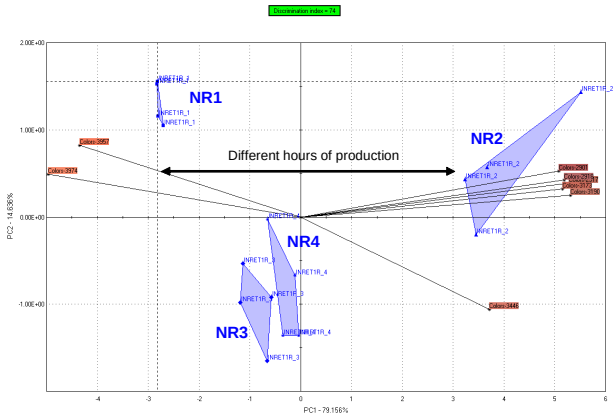


Figure 6: Principal Components Analysis of upper slices of all new recipe packages

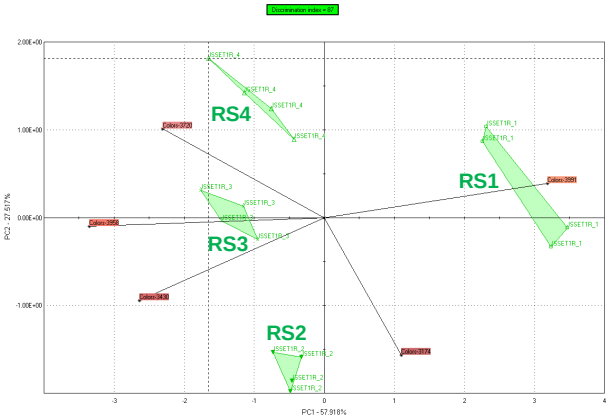


Figure 7: Principal Components Analysis of upper slices of all reduced salt recipe packages

Hierarchical Clustering Analysis (HCA) was applied to the measurements. This allows grouping the data into 3 color clusters:

- one linked with red color (code 3668)
- one linked with pink color (code 4006)
- one linked with white color (code 4095)

and quantifying the proportion of each color cluster on the ham slice surface.

Table 1 presents the average values of the cluster proportions (area percentage) for the three recipes of ham:

	% of red color 3668	% of pink color 4006	% of white color 4095
New recipe	22.6	76.8	0.4
Current recipe	19.6	79.2	0.4
Reduced salt recipe	60.3	37.4	0.4

Table 1: Average proportion (area percentage) of each color cluster by ham recipe

The current and the new recipe show similar proportions of each color cluster, with a predominance of pink cluster.

The reduced salt ham contains less pink but much more red. The lower proportion of pink may be due to the reduced salt content, nitric salts being known to be responsible for the pink color and the good preservation of the ham.

Shape Analysis

On the pictures of the isolated slices (taken out of the package), various shape parameters were analysed, such as surface, roundness and extension.
As for color analysis, the shape data are processed by Principal Components Analysis (fig. 8) to compare all samples more easily.

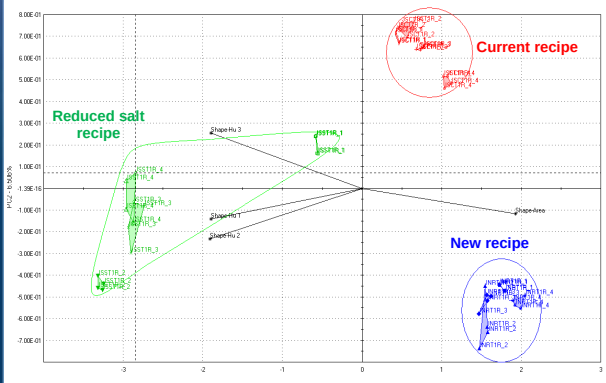


Fig. 8: Principal Components Analysis of upper slices of all ham packages based on shape parameters

Shape analyses highlight that the three recipes have distinct shape profiles. Within the two groups of current and new recipes, ham slices have a consistent shape from one package to another.
As for color analysis, it appears that the ham from package n°1 of the reduced salt recipe (RS1) is quite different from the three other packages in terms of shape.

Conclusion

The analysis of ham slices with IRIS electronic eye allowed detecting and characterizing the visual differences between the three recipes of ham slices.
This application suggests that IRIS electronic eye can be employed for product benchmarking or at line quality control purposes.